microcontrollers' survey

news from the world of bit crunchers

These days a perplexing number of microcontroller types are available. Embedded, single-chip, RISC, 8-bit, 16-16, surface-mount, flatpack, you name it, it's turmoil! The microcontroller world is bustling with activity, and there are new arrivals almost every week. In this article we will look at some of the latest developments in this ever-active field.

By our Editorial Staff

Although there is only a small and very slow increase in the number of microcontroller manufacturers, this is in stark contrast with the rocketing number of different versions, types and sub-types of these components. With this in mind, we had to limit ourselves to look at the latest developments only. So, instead of a complete overview of all microcontrollers currently available on the market we will concentrate on those products that can be called 'recent introductions'.

ATMEL

Founded not so long ago (in 1984), Atmel, in just a few years, have become one of the major forces in the microcontroller market. Atmel have always excelled at offering a product range that meets even the most extravagant demands from designers of microcontroller-based systems for a wide variety of applications.

Below are short descriptions of Atmel's most recent products.

AT90S8535, this one has an 8-kByte ISP Flash program memory, 512 kBytes of ISP (in-system programmable) EEPROM and an identical amount of SRAM for data;

AT90S4434 and AT90S4433, both having 4 kBytes of Flash ISP program memory, 256 bytes of ISP EEPROM, and 256 and 128 bytes of SRAM data memory;

ATmega603 with a massive 64 kBytes of ISP Flash program memory, 2 kBytes of ISP EEPROM and 4 kBytes of SRAM for data storage.

Taking the ATmega103 as an example (from which the ATmega603 is a derived version), you are looking at a microcontroller with the computing power of a PC of about 15 years ago (128 kBytes ISP Flash memory, 4 kBytes ISP EEPROM, and 4 kBytes SRAM). The new device has 120 instructions, it can be programmed externally or in-system (ISP), its clock rate is 6 MHz, it has 32 input/output lines, three timers, an 8-channel 10-bit converter, a real-time clock (operating at 32 kHz), and a UART, all in a 64-pin TQFP package.

One of the best things about the megaAVR controllers (which, by the way, are 8-bit types), is that they allow the complete 16-bit instruction to be loaded and stored in one operation, using two addresses.

Another novelty is the ATtiny11, which is actually a low-voltage controller. The relevant supply voltages are 3 V for the ATtiny11 and 1.8 V for the ATtiny 11L. Its sole memory element is a 1-kByte Flash memory. This controller has 90 instructions, and is supplied in an 8-pin case!

With the introduction of the AT91 ARM Thumb, finally, Atmel ventures out into 16/32-bit ARM RISC technology.

The most recent model is the AT91M40400, which is also the latest device in a family of standard microcontrollers based on the ARM7TDM1 core. The ARM91M40400 is a fully static component capable of achieving 30 MIPs at a clock speed of 33 MHz and a low supply voltage between 2.7 V and 3.3 V. This device has rather a lot of peripheral circuitry, including data and address buses with a width of 32 bits, 37 registers with the same width, and an in-circuit emulator interface. It contains 4 kBytes of SRAM.

DALLAS SEMICONDUCTOR

As far as its microcontrollers are concerned, Dallas Semiconductors can not be said to have followed an innovative course. Rather, the accent has been on increasing speed and computing power. The series of microcontrollers currently produced by Dallas Semiconductor operates at clock rates up to 33 MHz. However, since they use only 4 clock cycles rather than 12 (for an 8051) to execute an instruction, these microcontrollers appear to run at a speed of 99 MHz.

The latest products from Dallas Semiconductor include:

DS80C130

A high-performance replacement of the 8051, without ROM or XRAM, but having 56 bytes of protected RAM.

DS80C320

Identical to the 80C130 but having a an on-chip watchdog and a supply level monitor. The DS80C323 is the 3-V version.

DS87C250

This controller has 16 kBytes of EPROM (OTP), 1 kBytes of SRAM, and various Power Management and EMI Reduction modes. The DS83C520 is a version with masked ROM, and the DS87C530, one with a real-time clock (RTC) and an NV RAM controller.

DS87C530

Integrating a real-time clock, the DS87C530 is compatible with the 8051, although it offers better performance and lower power consumption. The revised core needs only 4 clock cycles to execute an instruction, as opposed to 12 for the 8051. In fact, it offers the same performance as an 8051 running at 99 MHz. This new microcontroller offers 16 kBytes of EEPROM (UV or OTP), 1 kBytes of non-volatile MOVX SRAM, 2 serial ports, a watchdog timer, a supply voltage guard, dual data pointers, and advanced power management techniques. The device is, we believe, ideal for data logger systems.

ISSI (INTEGRATED SILICON SOLUTION, INC.)

The IS89C52 from ISSI is an 8-bit microcontroller with 8 kBytes of reprogrammable Flash memory. Capable of operating at a highest clock speed of 40 MHz the IS89C52 is without doubt one of the fastest microcontrollers in its class. As suggested by the type number, the new microcontroller is functionally compatible with the industry-standard 80C52 device. It offers, among others, 256 bytes of RAM, a serial I/O port suitable for multi-processor communications, and I/O extension circuitry plus a full-duplex UART. Sporting no fewer than 3 timer/counter units, the IS89C52 has four 8-bit input/output ports with a total of 32 input/output lines. Its memory addressing capacity is 64 kBytes of ROM and the same amount of RAM. The device is capable of protecting the program memory using encrypted verification (32 bytes), and lock-out bits (3 bits).

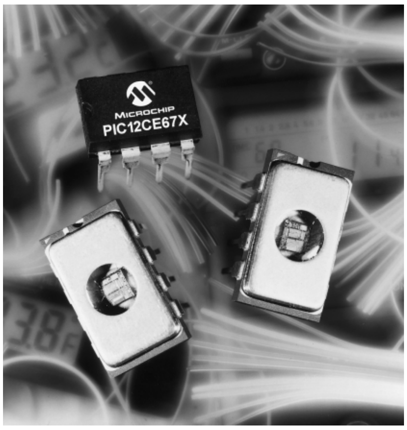
MICROCHIP

Microchip recently released five new microcontrollers on the market. The new **PIC16CE62X** and **PIC12CE67X** PICMicro™ families now offer protected EEPROM memory.

These 8-bit one-time programmable (OTP) microcontrollers present unbeatable security. In fact, to gain access to the EEPROM, the memory of the PIC16CE62 and PIC12CE67X has to be reprogrammed, which, in the case of OTP devices, is impossible! The new devices are claimed to be the smallest one-time programmable 8-bit RISC controllers in an 8-pin case. Offering one million write/clear cycles, Microchip's EEPROM technology also guarantees the longest period of data retention: more than 40 years.

The **PIC16CE623**, **624** and **625** offer 512 to 2048 words of one-time programmable memory, 128 bytes of EEPROM, and 96 up to 128 bytes of static RAM for data storage.

The **PIC16CE673** and **674** are the first 8-pin microcontrollers in the world with an on-chip 8-bit analogue-to-digital converter (ADC) as well as an EEPROM. Offering 1024 and 2048 OTP program memory with a word width of 14 bits, these integrated circuits also contain 128 bytes of static RAM and 16 x 8 bytes of EEPROM data memory.

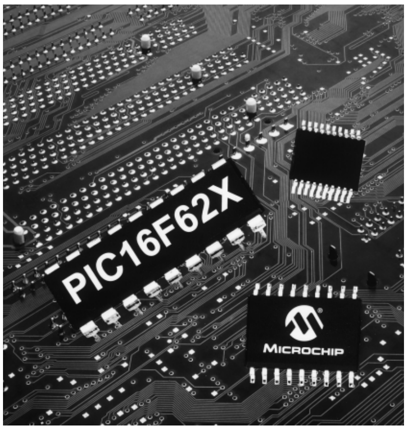


PIC17C7xx (**752**, **762** and **766**)

These microcontrollers take us to the 16-bit limits. Although they are strictly speaking 8-bit OTP microcontrollers, the devices in Microchip's PIC17Cxxx series offer functionality and performance levels that compete with 16-bit devices. These components in 64-pin and 84-pin cases contain 10-bit A-D converters and two high-speed USARTs. These PICs achieve a performance of 8.25 MIPs at a clock rate of 33 MHz, and so even surpass certain competing devices like the Motorola MC68HC11 and Hitachi's H8. Offering up to 16 kwords of 16-bit program memory in OTP EPROM and up to 902 bytes of user RAM, these new circuits comprise a one-cycle (120-ns) hardware 8x8 multiplication unit, and options for high-speed communication on 2 channels (duplex) using a USART with a speed of 8.25 million bits/s.

PIC16CR54C and **PIC16C505**

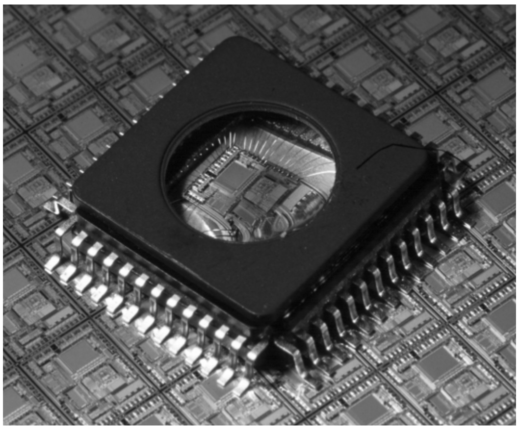
It seems that these devices actually are the most economic 8-bit OTP ROM controllers currently on the market. The PIC16CR54C, a ROM-based controller, and the PIC16C505, a one-time programmable chip, offer a galaxy of functions at a very low price. Packaged in a 14-pin enclosure, it is the first 8-bit



microcontroller to expand the possibilities of 8-pin designs with more I/O capacity, all at a cost of less than 50 dollar cents in volume quantities.

The PIC16C5050 has a memory with a capacity of 1024 words of 12-bits, 72 bytes of user RAM, 12 I/O pins, a wake-up circuit activated on I/O line state changes, and an internal 4-MHz clock oscillator. It is also capable of being programmed in-circuit, which means that the microcontroller does not have to be removed from the printed circuit board to receive a new program.

The ROM-based PIC16R54C is an 18-pin controller with a program memory of 512 words of 12 bits, 25 bytes of user RAM, and 12 I/O pins. These two circuits offer 33 one-word instructions, a programmable watchdog function with an on-chip RC oscillator for no-break operation, an instruction cycle time of 200 ns at a clock rate of 20 MHz, 7 hardware registers for special functions, a 2-register hardware stack, an 8-bit real-time timer/counter, a wide range for the supply voltage, and, last but not least, low power consumption: 2 mA at a clock rate of 4 MHz and a supply voltage of 5 V.



The following are the latest models announced at the Munich 'Electronics 98' exhibition.

PIC16F877 and **PIC16F876**

These new microcontrollers contain 8 kwords of 14-bit enhanced Flash memory, and 256 bytes of EEPROM-resident data memory. They offer the widest operating voltage known in the industry, namely between 2.0 V and 5.5 V. These are also the first controllers to employ Microchip's new MM (*Migratable Memory*) technology for the greatest possible system performance and design flexibility (say Microchip). The MM technology effectively ensures pin-for-pin and software compatibility of all microcontrollers, ROM-based, one-time programmable (OTP), or their Flash equivalents, and allows designers to choose the memory technology as a function of the expected application lifetime. It also enables easy migration to more cost-effective solutions, if necessary. These components contain a 10-bit A-D converter with 5 to 8 channels, a UART with RS485 compatibility for data acquisition applications in multi-channel systems, a computing performance of up to 5 MIPs at a clock speed of 5 MHz, options for I^{2}C bus communication or SPI for system expansion with peripheral circuits, and, finally, two 8-bit and one 16-bit timer.

A number of precision timing interfaces allow quantities to be captured and compared (16 bits) at respective resolutions of 12.5 ns and 200 ns, or PWM (pulsewidth modulation) signals to be generated with frequencies up to 20 kHz and a resolution of 10 bits. The devices allow up to 1,000,000 clear/program cycles, which is the highest number achieved in the industry today.

The PIC16F877 and PIC16F876 are the first 8-bit RISC-type PICmicro® controllers to integrate enhanced Flash memory technology.

PIC16F627 and **PIC16F628**

These new components comprise an internal 4-MHz clock oscillator, high-precision voltage comparators, a high-speed USART, and a capture/comparison/PWM module. These 18-pin microcontrollers contain 1024 and 2048 of 14-bit wide Flash program memory respectively, besides 224 bytes of RAM and 128 bytes of EEPROM for data storage. The highest clock speed is 40 MHz.

PIC16C733 and **PIC16C774**

These 8-bit microcontrollers integrate a sophisticated analogue technology for direct, programmable, interfacing to the power supply and for precision control of external systems. These parts, with 28 and 40 pins respectively, provide a complete system solution for mixed-signal environments, considerably reducing the number of discrete logic parts, associated parts and, of course, overall system cost. They integrate a 10-channel 12-bit A-D converter (±1 LSB) and a precision voltage reference (±3%), a programmable voltage-drop detector, and a programmable low-voltage detector (both with a current drain of 50 µA and an accuracy of ±3%).

With 4 kwords of 14-bit wide OTP memory, the PIC16C773 and PIC16C774 contain an RS485-style UART for multiple-data acquisition purposes, offering a throughput of up to 5 MIPs at a clock speed of 20 MHz, two 8-bit timers, one 16-bit timer, as well as possibilities for industry-standard I^{2}C and SPI communication buses.

MOTOROLA

Motorola recently introduced a new version of its 68HC08, the **68HC908GP20**, which, because of its in-system programmable (ISP) Flash memory, is said to be completely state-of-the-art. The GP20, as Motorola calls it, has 19,968 bytes of ISP Flash memory, 512 bytes of RAM, and offers a novel option called *Auto Wake-up Out of Stop*. It will faithfully run all instructions of the 68HC08, and allows designers having worked with the 68HC05 to upgrade to a larger model.

Silently, Motorola has also switched over to the use of Flash memory. The product range currently includes the 68F333, 68HC916Y1 and 68HC916X1.

Finally, we should not forget to mention the introduction of Motorola's new **68HC(7)05SB7**, which is basically a new version of the 68HC705. This chip was specifically developed for S*mart Battery* applications.

At the 16-bit microprocessor front, Motorola has three families available, the 68000, 68HC12 (in more than 10 different versions) and the 68HC16 (which comes in 8 different flavours).

NATIONAL SEMICONDUCTOR

National Semiconductor has really just one series of microcontrollers available, the COP8. This is an 8-bit processor which comes in no fewer than 82 different versions. The OTP versions of the COP8 have memory capacities of between 4 and 32 kBytes of OTP EPROM.

Quite recently, National Semiconductor launched a new OTP microprocessor called **COP8SGR7**. Having an EPROM memory of 32 kBytes, its price is remarkably low at less than 5 dollars for 1k+ order volumes.

Another recent arrival, the **COP8SGE7**, comes with 8 kBytes of OTP memory.

With its huge memory capacity, the COP8SGR7 allows designers to drastically reduce development time because there is no longer a need to compact the program code to make it fit in a memory (which is always too small!). Once the program has been tested and debugged, it may be burned into a ROM-based COP8 processor.

The COP8 family was recently extended with five new members: the COP8SGE5 (8 kBytes ROM), COP8SGG5 (16 k), COP8SGH (20 k), COP8SGK5 (24 k) and the COP8SGR5 (32 k).

All members of the COP8SGx family have a full-duplex UART/USART which is software programmable to enable quick implementation of various communication protocols. A pair of analogue comparators is available to detect zero-crossings, or for implementing a regular or 'dual-ramp' A-D converter function. These controllers have either 256 (SGE) or 512 (SGR) bytes of RAM.

The COP8SGR7 and COP8SGE7 guarantee perfect protection of the intellectual copyrights vested in the firmware code. Once the code has been made secure by means of an optional protection mechanism, the program is virtually impossible to 'hack'.

Finally, we should note that most applications of the COP8 family members are typically industrial.

PHILIPS SEMICONDUCTORS

Philips Semiconductors are obviously in a bid to offer the most extensive range of microcontrollers derived from the 'generic' 80C51.

89C51, **89C52**, **89C54** and **80C58**

The most recent microcontrollers from Philips Semiconductors are four Flash MTP (Multi Time Programmable) (sic, *Ed.*) Flash types in the extremely popular 80C51 family. These fledglings are called 89C51, 89C52, 89C54 and 80C58. The main point to make about these controllers is that they can be reprogrammed many times, and even in-system (ISP), which equates to a considerable reduction of two infamous factors, *cost* and *time to market*.

These new processors are capable of operating at up to 33 MHz, which makes them among the fastest 80C51 Flash processors currently available.

The difference between the various models is mainly the size of the on-chip Flash memory: 4 kBytes in the 89C51, and 8, 16 or 32 kBytes in the '52, '54 and '58 types respectively. The 89C51 has 128 bytes of RAM available, the other types, double that amount (128 bytes).

SCENIX

SX-18, SX-28

Scenix may rightly claim to be the company with the fastest 8-bit microcontrollers currently available on the market. Operating at up to 50 MHz and capable of executing the majority of instructions in just one clock cycle, the 'SX' Flash EEPROM microcontrollers from Scenix are good for up to 50 MIPs, which means that they are 10 to 50 times faster than a traditional 8-bit microcontroller.

The main characteristic of the SX, besides showing new roads towards evolution for all users of 8-bit microcontrollers, is that it enables '*Virtual Peripherals*' to be created (the term was obviously coined by Scenix). By virtue of the unmatched performance of the SX, the *Virtual Peripherals* are basically software implementations of functions that would otherwise require costly and dedicated hardware (mainly timers, PWM generators, and other serial ports).

There are actually two types of SX controller: easy to tell apart, really, because their number of pins is indicated by the type designation, 18 for the SX-18 and 28 for the SX-28.

The SX architecture is basically a copy of that used in Microchip's PICs. The SX is compatible with the PIC16C5x, and offers 10 additional instructions. One of the reasons for the technical success of the SX is the speed of its EEPROM program memory (2048 words of 12 bits) and its RAM-based registers (136 bytes) for data storage.

The instructions of the SX have a uniform length (12 bits) and most of them are executed in one clock cycle. Although the internal clock speed of the SX is 'just' 4 MHz, the controller outperforms a number of classic CPUs running at much higher speeds (12 or 33 MHz, for example), mainly because these require several clock cycles to execute a single instruction (12 cycles, for example, for the 8051).

Stop Press: Scenix just announced an addition to its production program: a new version of the SX18/28, called SX18/28AC100. As suggested by its type designation this number cruncher is capable of achieving a processing performance of up to 100 MIPs. Running at up to 100 MHz, the SX18/28AC100 executes one instruction in one clock cycle. At a data throughput of 100 MIPs, the resulting instruction cycle length is 10 ns. These two new versions sport 2 kwords of Flash/EEPROM memory with a width of 12 bits.

SGS-THOMSON MICROELECTRONICS

The ST6 Family

This is probably the best known series of 8-bit microcontrollers from SGS-Thomson. It comprises the following types: ST6200/1/3/8/9, ST6210/15/18, ST6220/25/28, ST6230/32, ST6240/42/46, ST6252/53/55, ST6260/62/63/65 and ST6280/85. Note that not all of these microcontrollers are available in a 28-pin or 40-pin DIL enclosure — a number of them are only supplied in a PQFP flatpack case.

Within this series, SGS-Thomson offers an EPROM, ROM and OTP version of each type. In this way, a good compromise is reached between design flexibility and low cost. The characteristics shared by ST6 family members include a maximum operating frequency of 8 MHz, a program memory with a size between 1 and 8 kBytes, and a RAM and (for some types) EEPROM capacity of 64 to 128 bits. The components that make up this series are specified to last 300,000 programming cycles, they have an on-chip 8-bit A-D converter, an SPI compatible serial interface, a UART, one (or two) 8-bit timers with pulsewidth modulation, and interrupt detection on all inputs.

The ST7 Family

This is the latest family of microcontrollers released by SGS-Thomson Microelectronics. It is based on an architecture that is still actively employed for the design of microcontrollers for specific applications like PC displays, remote control units, CD players or car radios with RDS.

The members of the ST7 family differ in respect of on-chip memory size, ranging from a modest 4 Kbytes of program memory and 128 bytes of RAM in the ST72101 right up to 32 kBytes of ROM/EPROM, 1024 bytes of RAM and 256 bytes of EEPROM in the ST72331. The IC cases have 28 up to 56 connecting pins.

Among the options for peripheral circuits are an 8-bit multi-channel ADC, SPI interfaces, I^{2}C, USB and CAN bus interfaces, and one or two 16-bit timers.

As far as performance is concerned, the ST72 series is situated about halfway between the low-cost ST62 family and the ST9 family with 8/16 bit registers.

The ST72 family is expected to be extended shortly with a couple of new members specially developed for applications like controlling LCDs or brushless motors.

The ST9 Family

This series contains a number of microcontrollers which are generally referred to as '8/16-bits'. The best known types are the ST90135 and the ST90R158.

The ST10 Family

This series of 16-bit microcontrollers is often said to combine the advantages of CISC and RISC. It comprises the following integrated circuits: ST10R165, ST10R163, ST10F163, (128 kBytes Flash memory), ST10R166, ST10F166 and ST10F167. To these will be shortly be added the ST10R272L and the ST10F168. Clock frequency is rated at up to 20 MHz and the memory is 128 kBytes Flash. These new controllers are compatible with the C16x family from Siemens.

The ST20 Family
This is the 32-bit family of microcontrollers produced by SGS-Thomson.

SIEMENS

The C500 from Siemens is one of the most interesting microcontroller series. The latest addition is called **C505L**. This 8-bit device is offered as a *single-chip* solution. This processor, a descendant of the generic 8051, is the first to be supplied with an on-chip LCD interface.

The C505L is totally compatible with the industry-standard 80C51 and 80C52. It integrates a 32-kByte OTP memory, 512 bytes of RAM, a synchronous/asynchronous serial interface, and a very accurate 10-bit A-D converter boasting a conversion time of just 6 µs. The on-chip LCD controller may drive a 128-segment LCD (i.e., 4 lines of 32 characters); it has 36 LCD outputs of which 20 are reserved for display functions. The remaining 16 outputs may be used as conventional I/O lines. At a clock frequency of 20 MHz, the cycle period is about 300 ns. The real-time clock on the chip also supports a *power-down* mode in which the current consumption drops to just 50 µA (at a supply voltage of 3.3 V and a clock frequency of 32 kHz).

TEMIC

Temic recently launched their **TSC8051i2**, a new 8-bit microcontroller which, according to the manufacturer, integrates a multimaster I^2C controller, analogue PWM outputs and a traditional watchdog circuit.

The two-wire I^2C bus has become an industry standard mainly because it is so simple and versatile. The TSC8051i2 contains a multimaster I^2C controller which presents an economic solution to designers wishing to implement the I^2C bus.

As indicated by its type number, the TSC8051i2 is based on the architecture of Intel's 80C51. In addition to the multimaster I^2C controller, the Temic micro contains 8 kBytes of OTP/EPROM or ROM, 256 bytes of RAM, 2 timers and a UART. It runs at a clock rate of 24 MHz at 5 V, and will soon be available in a 3-V version capable of running at 16 MHz.

ZILOG

In the wake of the famous Z8 from Zilog are a number of follow-up devices designated 'Z86'. This is quite a large family:
Z86C34/35/36/44/45/46, Z86E34/44, Z86144, Z8E001, Z86E02/C02/L02, Z86E03/06/C03/06/L06/16, Z86E04/C04/L04, Z86E08/C08/L08, Z86E30/31/40, Z86C33/43, Z86C83/84.
There also exists a new series of derived products called **Z8Plus**. The core of these controllers presents a number of advantages over the classic Z8 core. These advantages include higher processing speed resulting from a lower system clock pre-division factor.

When clocked at 10 MHz, controllers based on the Z8Plus core achieve a performance level equal to that of a classic Z8 running at 16 MHz. The first product is the **Z8E001**, an OTP device with 1 kBytes of program memory, a 64-bytes register array, 3 timers (including PWM) and an analogue comparator, all in an 18-pin case.
Z86144
This new product offers 16 bytes of EEPROM space which may be addressed in three different ways: (1) by user code, (2) externally by means of two interface protocols, or (3) in '*EEMODE*' which allows programming and access on a byte-by-byte basis.

There are many other manufacturers of microcontrollers, including Analog Devices, Arm, Fujitsu, Harris Semiconductor, Hitachi, IDT, Mitsubishi, NEC, OKI, Samsung, Sharp and Texas Instruments. Because of various reasons their products could not be discussed in this survey.

CONCLUSION

Based on current market tendencies, the outlook is: more computing power, higher speeds. An increasing number of dedicated or application-specific microcontrollers is noticed. These devices are tailor-made to perform one specific function only, often having very specific circuitry on board, as required by the application for which they were designed.

Note
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BTW an excellent search engine may be found at: http://www.800go.com.